Chapter 18 Cost-Effectiveness Analysis (CEA)

Cost-Effective Analysis (CEA) is a widely used alternative to CBA, especially health and defense policy. CEA compares (mutually exclusive) alternatives in terms of the ratio of their costs and a single quantified, but not monetized, effectiveness measure.

Three common constraints to doing CBA

> If CBA is not possible, CEA may give useful information concerning the relative efficiency of alternatives.

1. Unwilling or unable to monetize the most important policy impact.
2. A particular effectiveness measure does not capture all of the social benefits of each alternative, and some of these other social benefits are difficult to monetize.
3. Dealing with intermediate goods whose linkage to preferences is not clear.

Cost-Effectiveness Ratios

Costs (C) are measured in monetary terms.

Effectiveness (E) may be measured in units such as lives saved, tons of carbon dioxide reduction, children vaccinated.

Two ways: *Cost-Effectiveness ratio* (CE ratio) more commonly used.

Effectiveness-Cost ratio (EC ratio)

Incremental CE ratio: Alternatives policy *i* and policy *j*

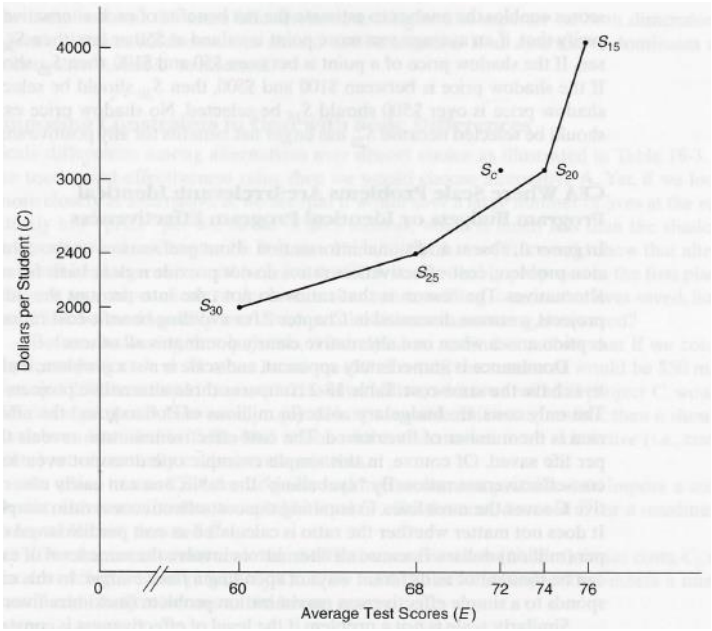
*i:*policy implementation(with), *j:*status quo(without)

$$CE_{ij} = \frac{C}{E} = \frac{C_i - C_j}{E_i - E_j}$$

Application of Cost-Effectiveness Ratio

Student achievement Scores

	C (*dollars per student*)	E (*average test score*)	C/E (*relative to no schooling*)	S_j (*basis for comparison*)	ΔC (*relative to S_j*)	ΔE (*relative to S_j*)	ΔC/ΔE (*incremental cost-effectiveness ratio*)
S_{30}	2000	60	33.3	—	—	—	—
S_{25}	2400	68	35.3	S_{30}	400	8	50
S_{20}	3000	74	40.5	S_{25}	600	6	100
S_{15}	4000	76	52.6	S_{20}	1000	2	500
S_c	3000	72	41.7	S_{30}	1000	12	83.3



Frontier: best possible outcome
southeast as possible

S_c: Extended (weak) dominance

…to eliminate from considered alternatives.

located at northwest of the frontier

If assigning a shadow price to average test score, how about NPV?

Cost-Effectiveness Analysis in Same Scale

	Alternatives		
Cost and Effectiveness	*A*	*B*	*C*
Cost measure (budget cost)	$10M	$10M	$10M
Effectiveness measure (number of lives saved)	5	10	15
CE ratio (cost per life saved)	$2.0M	$1.0M	$0.67M[a]
EC ratio (lives saved per million dollars)	0.5 life	1.0 life	1.5 lives[a]

[a] *CE ratio or EC ratio of the most cost-effective alternative.*

Fixed cost: Maximize effectiveness (lives saved)
Fixed effectiveness: Minimize cost (dollars)

Imposing Constraints to deal with Scale Differences

	Alternatives	
Cost and Effectiveness	***A***	***B***
Cost measure (budget cost)	$1M	$100M
Effectiveness measure (number of lives saved)	4	200
CE ratio (cost per life saved)	$250,000[a]	$500,000
EC ratio (lives saved per million dollars)	4.0 lives[a]	2.0 lives

[a] *CE ratio or EC ratio of the most cost-effective alternative.*

$$Min\ C_i \qquad Min\ CE_i \qquad Max\ E_i \qquad Min\ CE_i$$

$$s.t.\ E_i \geq \overline{E} \qquad s.t.\ E_i \geq \overline{E} \qquad s.t.\ C_i \leq \overline{C} \qquad s.t.\ C_i \leq \overline{C}$$

$\overline{E}$: Minimum acceptable level of effectiveness

$\overline{C}$: Maximum acceptable level of cost

Illustration of the Different CE Rules

				$E \geq 50$		$C \leq 250$	
Projects (1)	*Lives Saved (2)*	*Budget Cost ($M) (3)*	*CE Ratio (cost per life saved) ($M/life saved) (4)*	*Budget Cost of Projects That Save at Least 50 Lives (5)*	*CE Ratio of Projects That Save at Least 50 Lives (6)*	*Lives Saved of Projects That Cost No More than $250M (7)*	*CE Ratio of Projects That Cost No More than $250M (8)*
A	100	250	2.5	250	2.5[a]	100[a]	2.5
B	20	44	2.2	—	—	20	2.2
C	100	300	3.0	300	3.0	—	—
D	50	300	6.0	300	6.0	—	—
E	10	20	2.0[a]	—	—	10	2.0[a]
F	100	900	9.0	900	9.0	—	—
G	60	210	3.5	210	3.5	60	3.5
H	50	200	4.0	200[a]	4.0	50	4.0
I	40	100	2.5	—	—	40	2.5
J	45	110	2.4	—	—	45	2.4

[a] *CE ratio, budget cost, or effectiveness of the most preferred alternative*

Chapter 20 How Accurate is CBA?

Sources of Error in CBA Studies

1. Omission Errors: to exclude some impact category completely.

   by "uncertainty of the fundamental scientific relationship"

2. Forecasting Errors: to arise due to the difficulty of predicting technological change, cognitive biases, changing project specifications, etc.

   by "uncertainty" and "Over optimism: underweight low-probability *bad* events and overweight low-probability *good* events".

3. Valuation Errors: Difficulty of accurate monetary estimates of the social value.

4. Estimation/ Measurement Errors: Impact are often observed, recorded or interpreted inaccurately.

Choosing among Projects (in Chapter 2)

Net Present Value $$NPV = \sum_{t=0}^{t=n} \frac{B_t - C_t}{(1+i)^t} = \sum_{t=0}^{t=n} \frac{B_t}{(1+i)^t} - \sum_{t=0}^{t=n} \frac{C_t}{(1+i)^t} = PVB - PVC$$

Cost Benefit Ratio $$CBR = \sum_{t=0}^{t=n} \frac{B_t}{(1+i)^t} \Bigg/ \sum_{t=0}^{t=n} \frac{C_t}{(1+i)^t} = PVB / PVC$$

	Costs (millions of dollars)	*Benefits (millions of dollars)*	*Net Benefits (millions of dollars)*	*Benefits/Costs*
No project	0	0	0	–
Project A	1	10	9	10
Project B	10	30	20	3
Project C	4	8	4	2
Project D	3	5	2	1.7
Projects C and D	7	21	14	3
Project E	10	8	−2	0.8

(1) No constraints: Choose A, B, and combination C and D (net benefits equal $43 million).
(2) All projects mutually exclusive: Choose B (net benefits equal $20 million).
(3) Total costs cannot exceed $10 million: Choose A and combination C and D (net benefits equal $23 million).